

From: Chief, Bureau of Ships.

To: All Holders of General Specifications for Machinery for Vessels of the United States Navy,
BuShips Mailing List 451-A.

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M. J. Lawrence,
By direction**GENERAL SPECIFICATIONS FOR MACHINERY
FOR VESSELS OF THE UNITED STATES NAVY**

DEPARTMENT OF THE NAVY, BUREAU OF SHIPS

SECTION S39-2**THERMAL INSULATION FOR MACHIN-
ERY AND PIPING**

Superseding section S39-2, dated 1 May 1947.

5 S39-2-a. Purchase specifications

Issue in effect at date of invitation for bids shall apply.

- Copies of Federal (Fed.) specifications, Military (MIL) specifications, Navy Department (N.D.) specifications and Bureau of Ships specifications may be obtained from the Bureau of Supplies and Accounts, or Bureau of Ships, Navy Department, Washington 25, D. C. Naval activities should apply to Commanding Officer, Naval Supply Depot, Scotia 2, N. Y.

15 S39-2-b. Scope

- These specifications cover requirements for insulating and lagging machinery and piping. Where detail specifications herein do not specifically apply to any surface requiring insulation, such surfaces shall be insulated according to the requirements covering a condition which most nearly approximates that of the surface in question.

S39-2-c. Definitions

- 25 Insulating material.—Material employed to offer resistance to the flow of heat.

Lagging.—Protective and confining covering or jacket placed over insulating material.

- 30 Fastening.—Miscellaneous items with which insulating material is attached to the surface being covered and with which lagging is fixed to insulating material.

Machinery covering and pipe covering.—Composite covering including insulating material, lagging and fastening.

- 35 Cold piping.—Piping, the surface temperature of which is below 100° F. except that refrigerant lines designed for refrigeration are defined as "refrigerant piping."

S39-2-d. General design and requirements

- 40 Insulate all hot external surfaces of mechanical equipment such as boilers, evaporators, heaters, turbines, boiler feed pumps and feed booster pumps, pipe

and tubing, valves and fittings as specified herein. Do not insulate flanged joints in fuel oil piping from fuel oil heaters to and including burner headers. These provisions apply where the temperature of the surface is normally 100° F. or above. 45

Cold piping and refrigerant piping.—Insulate as specified herein. See table 1.

All cold piping located above floor level shall be covered with antisweat insulation which shall be protected against moisture absorption, rotting and disintegration under service conditions. Cold piping below floor level need not be covered except in dry storerooms or other locations where condensed moisture may be undesirable. 50 55

Diesel engine exhaust.—All piping, valves, and fittings located in positions exposed to the weather or to salt water spray shall not be insulated but shall be coated on the outside with protective coating, Mil. Spec. MIL-P-15143. 60

Steam piping.—Insulate all piping, valves and fittings located in positions exposed to the weather or to salt water spray and lag watertight with sheet metal. Where it is not feasible to apply insulation, coat piping with protective coating, Mil. Spec. MIL-P-15143. 65

Protection of personnel.—In general to be given every consideration by installing suitable guards where hot piping is exposed, removing ragged and serrated edges from sheet metal lagging, and removal of any other hazards which may present themselves. 70

Pipe anchorages and hangers.—Insulation shall be as complete and efficient as practical. Design shall be such as to reduce heat conducting paths to a minimum. Where temperature of confined fluid exceeds 650° F., thermal insulation shall not be used but pipe hangers shall be designed using low conductivity metals with small areas of contact. Where temperature of confined fluid is 650° F. or less, hangers shall be insulated by low conductivity metals with small areas of contact or by sheet asbestos, asbestos cloth, or other approved material installed between clamp and the piping to a radial thickness not exceeding 1/8 inch. Insulating material around the pipe clamp, particularly in the lower arc, to be adequately supported. 75 80 85

Install insulation so as to insure ready removal and replacement as necessary for service maintenance and repair of the insulated apparatus without destruction or deterioration of such covering. Fastening shall be

such as to prevent crushing or otherwise reducing the insulating value of the material used.

Finishing cement.—Where these specifications require the use of a layer of finishing cement, any of the following materials, applied and troweled smooth, will be acceptable:

(a) Cement, insulation, asbestos, finishing, N.D. Spec. 32C16.

(b) Cement, insulation, high-temperature, type B, N.D. Spec. 32C14 when used under asbestos lagging.

(c) A mixture of 80 percent cement, insulation, high-temperature, type B (N.D. Spec. 32C14) and 20 percent Portland cement (Fed. Spec. SS-C-192).

Pipe covering shall not be fitted on any piping in voids, cofferdams or tanks, nor shall it cover drain plugs, spectacle flanges or strainer cleanouts.

Air piping.—Insulate where passing through magazines.

Hot water systems.—Insulate completely, including heating tanks, up to the fixtures.

Fire systems.—Insulate completely.

Fresh water systems and flushing systems.—Insulate completely up to the fixtures.

Sprinkling systems, all normally wet piping.—Insulate.

Plumbing and deck drains.—Insulate as necessary to prevent sweating.

Before applying insulation paint machinery and piping in accordance with General Specifications for Building Vessels, Appendix 6.

Insulation shall not be installed on piping connec-

tions or joints of any type during pressure tests or until piping has passed satisfactory inspection.

S39-2-e. Detail requirements

The following tables indicate various approved insulating, lagging and fastening materials which shall be used and minimum thicknesses required for all services and temperature ranges.

LIST OF MATERIALS

Materials:	Specification
Cement, adhesive.....	MIL-C-3316
Cement, insulation, asbestos, finishing.....	32C16
Cement, insulation, high-temperature.....	32C14
Cloth, strands, and tape, asbestos.....	SS-C-466
Cloth, tape and thread; glass, fibrous.....	32G9
Cork, compressed (corkboard).....	HH-C-561
Felt, insulating, asbestos.....	MIL-F-15091
Insulation, blanket, mineral-wool.....	32-I-2
Insulation, glass, fibrous; sheets.....	MIL-I-18475
Insulation, mineral-wool, pipe-covering.....	32-I-5
Insulation, thermal block.....	32-I-3
Millboard, asbestos.....	32M1
Paint, inside, semi-gloss, white, fire-retardant.	JAN-P-702
Paper, sheathing, flameproof and water-repellent.	MIL-P-15006
Pipe covering, cork, molded (with fire resisting compound).	MIL-P-876
Pipe covering, thermal-insulation.....	MIL-P-2781
Plaster, magnesia.....	32P10
Protective coating (heat hardening) phenol-formaldehyde.	MIL-P-15143
Steel, sheet, zinc-coated (galvanized).....	47829
Tape, insulating, thermal.....	MIL-T-15349
Tape, masking.....	UU-T-106
Wire, copper, soft or annealed.....	22W9

TABLE 1

Service	Temperature conditions (° F.)	Pipe or tubing		Valves and fittings		Flange joints		Machinery	
		Insulating materials	Lagging	Insulating materials	Lagging	Insulating materials	Lagging	Insulating materials	Lagging
Steam, superheated; gases, exhaust.	751 to 900....	MIL-P-2781, grade 3; MIL-T-15349.	SS-C-466, type I, grade A, type IV; 32G9.	32C14, type B MIL-F-15091 type A, 32-I-3, class b; MIL-P-2781, grade 3.	SS-C-466 type I, grade A, B, C, D, type IV; 32G9.	MIL-F-15091 type A, 32-I-3, class b; 32P8, grade 3.	SS-C-466 type I, grade C, D.	32C14, type B MIL-F-15091 type A, 32-I-2, 32-I-3, class b.	SS-C-466, type I, grade A, B, C, D, type IV; 32G9.
Steam, superheated; gases, exhaust.	501 to 750....	MIL-P-2781 grade 2 & 3 MIL-T-15349.	SS-C-466, type I, grade A, type IV; 32G9.	32C14, type B MIL-F-15091 type A, 32-I-3, class b; MIL-P-2781 grade 2 & 3.	SS-C-466 type I, grade A, B, C, D, type IV; 32G9.	MIL-F-15091 type A, 32-I-3, class b; 32P8, grade 2 & 3.	SS-C-466, type I, grade C, D.	32C14, type B MIL-F-15091 type A, 32-I-2, 32-I-3, class b.	SS-C-466, type I, grade A, B, C, D, type IV; 32G9.
Steam, saturated; gases, exhaust; water, hot; oil, fuel hot.	100 to 500....	MIL-P-2781 grade 1, 2; MIL-T-15349.	SS-C-466, type I, grade A, type IV; 32G9; 47829.	32C14, type B MIL-F-15091 type A, 32-I-3, class a; MIL-P-2781, grade 1 & 2.	SS-C-466, type I, grade A, B, C, type IV; 32G9.	32C14, type B MIL-F-15091 type A, 32-I-3, class a; 32P8, grade 1 & 2.	SS-C-466 type I, grade A, B, C, type IV.	32C14, type B MIL-F-15091 type A, 32-I-2, 32-I-3, class a.	SS-C-466, type I, grade A, B, C, type IV; 32G9.
Water, cold....	32 to 99.....	MIL-F-15091 type A & B; 32-I-5.	SS-C-466, type I, grade A, type IV; 32G9; 59P7.	MIL-F-15091 type A & B; 32-I-5.	SS-C-466 type I, grade A, type IV; 32G9; MIL-P-15006.	MIL-F-15091 type A & B; 32-I-5.	SS-C-466 type I, grade A, type IV; 32G9; MIL-P-15006.	MIL-F-15091 type A & B.	SS-C-466 type I, grade A, type IV; 32G9; MIL-P-15006.
Refrigerant (including chilled water).	36 and above.	MIL-P-876 class 1.	SS-C-466 type I, grade A, type IV; 32G9.	MIL-P-876 class 1.	SS-C-466 type I, grade A, type IV; 32G9.	MIL-P-876 class 1.	SS-C-466 type I, grade A, type IV; 32G9.	HH-C-561....	SS-C-466, type I, grade A, type IV; 32G9.
Refrigerant....	0 to 35.....	MIL-P-876, class 2.	SS-C-466 type I, grade A, type IV; 32G9.	MIL-P-876, class 2.	SS-C-466 type I, grade A, type IV; 32G9.	MIL-P-876, class 2.	SS-C-466 type I, grade A, type IV; 32G9.	HH-C-561....	SS-C-466, type I, grade A, type IV; 32G9.
Refrigerant....	Below 0.....	MIL-P-876 class 3.	SS-C-466 type I, grade A, type IV; 32G9.	MIL-P-876, class 3.	SS-C-466 type I, grade A, type IV; 32G9.	MIL-P-876 class 3.	SS-C-466 type I, grade A, type IV; 32G9.	HH-C-561....	SS-C-466, type I, grade A, type IV; 32G9.

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Table 2.—Compounded insulating material thicknesses for hot pipe or tubing

Pipe size (inches)	Temperature range (° F)	Class of material MIL-P-2781		Thickness (inches)		
		Inner layer	Outer layer	Inner layer	Outer layer	Total
$\frac{1}{2}$ and $\frac{3}{4}$	100-388	a, b, or d.....		$\frac{3}{8}$		$\frac{3}{8}$
	389-500	a or.....		$1\frac{1}{8}$		$1\frac{1}{8}$
		b or d.....		$1\frac{1}{8}$		$1\frac{1}{8}$
	501-750	d or.....		$1\frac{1}{8}$		$1\frac{1}{8}$
		e.....		$1\frac{1}{8}$		$1\frac{1}{8}$
1.....	751-900	e.....		$1\frac{1}{8}$		$1\frac{1}{8}$
	100-388	a or.....		$\frac{3}{8}$		$\frac{3}{8}$
		b or d.....		$1\frac{1}{8}$		$1\frac{1}{8}$
	389-500	a or.....		$1\frac{1}{8}$		$1\frac{1}{8}$
		b or d.....		$1\frac{1}{8}$		$1\frac{1}{8}$
	501-750	d or.....		$1\frac{1}{8}$		$1\frac{1}{8}$
		e.....		$1\frac{1}{8}$		$1\frac{1}{8}$
	751-900	e.....		$1\frac{1}{8}$		$1\frac{1}{8}$
Same materials and thicknesses as $\frac{1}{2}$ inch size						
$1\frac{1}{4}$	100-388	a or.....		$\frac{3}{8}$		$\frac{3}{8}$
		b or d.....		$1\frac{1}{8}$		$1\frac{1}{8}$
	389-500	a or.....		$1\frac{1}{8}$		$1\frac{1}{8}$
		b or d.....		$1\frac{1}{8}$		$1\frac{1}{8}$
	501-750	d or.....		$1\frac{1}{8}$		$1\frac{1}{8}$
2 and $2\frac{1}{2}$		e.....		$1\frac{1}{8}$		$1\frac{1}{8}$
	751-900	e.....		$1\frac{1}{8}$		$1\frac{1}{8}$
	100-388	a, b, or d.....		$1\frac{1}{8}$		$1\frac{1}{8}$
	339-388	a or.....		2		2
		b or d.....		$1\frac{1}{8}$		$1\frac{1}{8}$
	389-500	a, b, or d.....		3		3
	501-750	d or.....		3		3
		e.....		$1\frac{1}{8}$	$1\frac{1}{8}$	$3\frac{1}{8}$
	751-900	e.....	a or b.....	$1\frac{1}{8}$	$1\frac{1}{8}$	$3\frac{1}{8}$
3.....	100-388	a, b, or d.....		$1\frac{1}{8}$		$1\frac{1}{8}$
	339-388	a or.....		2		2
		b or d.....		$1\frac{1}{8}$		$1\frac{1}{8}$
	389-500	a, b, or d.....		3		3
	501-750	d or.....		3		3
		e.....		$1\frac{1}{8}$		$1\frac{1}{8}$
	751-900	e.....	a or b.....	$1\frac{1}{8}$	2	$3\frac{1}{8}$
	100-388	a or.....	a or b.....	$1\frac{1}{8}$	2	$3\frac{1}{8}$
		b or d.....		$1\frac{1}{8}$		$1\frac{1}{8}$
	339-388	a, b, or d.....		2		2
$3\frac{1}{2}$	389-500	a, b, or d.....		3		3
	501-750	d or.....		3		3
		e.....		$1\frac{1}{8}$	$1\frac{1}{8}$	$3\frac{1}{8}$
	751-900	e.....	a or b.....	$1\frac{1}{8}$	$1\frac{1}{8}$	$3\frac{1}{8}$
		b or d.....		$1\frac{1}{8}$		$1\frac{1}{8}$
4.....	100-388	a, b, or d.....		$2\frac{1}{8}$		$2\frac{1}{8}$
	339-388	a or.....		$1\frac{1}{8}$		$1\frac{1}{8}$
		b or d.....		$1\frac{1}{8}$		$1\frac{1}{8}$
	389-500	a, b, or d.....		3		3
	501-750	d or.....		3		3
		e.....		$1\frac{1}{8}$	$1\frac{1}{8}$	$3\frac{1}{8}$
	751-900	e.....	a or b.....	$1\frac{1}{8}$	$1\frac{1}{8}$	$3\frac{1}{8}$
	100-388	a or.....	a or b.....	$1\frac{1}{8}$	2	$3\frac{1}{8}$
		b or d.....		$1\frac{1}{8}$		$1\frac{1}{8}$
	339-388	a, b, or d.....		$2\frac{1}{8}$		$2\frac{1}{8}$
$4\frac{1}{2}$	389-500	a, b, or d.....		3		3
	501-750	d or.....		3		3
		e.....		$1\frac{1}{8}$	$1\frac{1}{8}$	$3\frac{1}{8}$
	751-900	e.....	a or b.....	$1\frac{1}{8}$	2	$3\frac{1}{8}$
	100-388	a or.....	a or b.....	$1\frac{1}{8}$	2	$3\frac{1}{8}$
		b or d.....		$1\frac{1}{8}$		$1\frac{1}{8}$
	339-388	a or.....		$2\frac{1}{8}$		$2\frac{1}{8}$
		b or d.....		2		2
	389-500	a, b, or d.....		3		3
	501-750	d or.....		3		3
		e.....		$1\frac{1}{8}$	$1\frac{1}{8}$	$3\frac{1}{8}$
	751-900	e.....	a or b.....	$1\frac{1}{8}$	$1\frac{1}{8}$	$3\frac{1}{8}$
Same materials and thicknesses as 4 inch size						
5.....	100-388	a, b or d.....		$1\frac{1}{8}$		$1\frac{1}{8}$
	339-388	a or.....		$2\frac{1}{8}$		$2\frac{1}{8}$
		b or d.....		$2\frac{1}{8}$		$2\frac{1}{8}$
	389-500	a, b or d.....		3		3
	501-750	d or.....		4		4
		e.....		$1\frac{1}{8}$	2	$3\frac{1}{8}$
	751-900	e.....	a or b.....	$1\frac{1}{8}$	2	$3\frac{1}{8}$
	100-388	a or.....	a or b.....	$1\frac{1}{8}$	2	$3\frac{1}{8}$
		b or d.....		$1\frac{1}{8}$		$1\frac{1}{8}$
	339-388	a or.....		$2\frac{1}{8}$		$2\frac{1}{8}$
	389-500	a, b, or d.....		3		3
	501-750	d or.....		3		3
		e.....		$1\frac{1}{8}$	$1\frac{1}{8}$	$3\frac{1}{8}$
	751-900	e.....	a or b.....	$1\frac{1}{8}$	$1\frac{1}{8}$	$3\frac{1}{8}$
		b or d.....		$1\frac{1}{8}$		$1\frac{1}{8}$
Same materials and thicknesses as 4 inch size						
6.....	100-388	a, b or d.....		$1\frac{1}{8}$		$1\frac{1}{8}$
	339-388	a or.....		$2\frac{1}{8}$		$2\frac{1}{8}$
		b or d.....		$2\frac{1}{8}$		$2\frac{1}{8}$
	389-500	a, b or d.....		3		3
	501-750	d or.....		4		4
		e.....		$1\frac{1}{8}$	2	$3\frac{1}{8}$
	751-900	e.....	a or b.....	$1\frac{1}{8}$	2	$3\frac{1}{8}$
	100-388	a, b, or d.....		$1\frac{1}{8}$		$1\frac{1}{8}$
	339-388	a or.....		$2\frac{1}{8}$		$2\frac{1}{8}$
		b or d.....		$2\frac{1}{8}$		$2\frac{1}{8}$
8, 9, and 10.....	389-500	a, b or d.....		3		3

Table 2—Compounded insulating material thicknesses for hot pipe or tubing—Continued

Pipe size (inches)	Temperature range (° F)	Class of material MIL-P 2781		Thickness (inches)		
		Inner layer	Outer layer	Inner layer	Outer layer	Total
8, 9, and 10.....	501-750	d or.....	.....	4	.....	4
	751-900	e.....	a or b.....	2	2	4
11.....	100-338	e.....	a or b.....	2	2	4
	339-500	a, b, or d.....	.....	1½	.....	1½
	501-750	a, b, or d.....	.....	3	.....	3
	751-900	d or.....	.....	4	.....	4
12 and over.....	501-750	e.....	a or b.....	2	2	4
	751-900	e.....	a or b.....	2	2	4
	100-338	a, b, or d.....	.....	1½	.....	1½
	339-500	a, b, or d.....	.....	3	.....	3
	501-750	d or.....	.....	4	.....	4
	751-900	e.....	a or b.....	2	2	4

Table 3.—Fibrous insulating material thicknesses for hot pipe or tubing

Pipe size (inches)	Temperature range (° F)	Class of material MIL-P-2781		Thickness (inches)		
		Inner layer	Outer layer	Inner layer	Outer layer	Total
½ through 1½.....	100-388	c.....	.....	¾	.....	¾
	389-500	c.....	.....	1½	.....	1½
	501-750	c.....	.....	2	.....	2
	751-900	f.....	.....	2	.....	2
2 through 3½.....	100-338	c.....	.....	1½	.....	1½
	339-388	c.....	.....	2	.....	2
	389-500	c.....	.....	2½	.....	2½
	501-750	c.....	.....	3	.....	3
	751-850	f.....	c.....	1½	2	3½
	851-900	f.....	c.....	1½	1½	3½
4 through 6.....	100-338	c.....	.....	1½	.....	1½
	339-388	c.....	.....	2	.....	2
	389-500	c.....	.....	2½	.....	2½
	501-750	c.....	.....	3	.....	3
	751-850	f.....	c.....	1½	2	3½
	851-900	f.....	c.....	2	1½	3½
7 through 11.....	100-338	c.....	.....	1½	.....	1½
	339-388	c.....	.....	2½	.....	2½
	389-500	c.....	.....	2½	.....	2½
	501-750	c.....	.....	4	.....	4
	751-850	f.....	c.....	1½	2½	4
	851-900	f.....	c.....	2	2	4
12 and over.....	100-338	c.....	.....	1½	.....	1½
	339-388	c.....	.....	2½	.....	2½
	389-500	c.....	.....	2½	.....	2½
	501-750	c.....	.....	4	.....	4
	751-850	f.....	c.....	1½	2½	4
	851-900	f.....	c.....	2	2	4

Table 4.—Thicknesses of insulating tape, MIL-T-15349 for hot piping ¼ and ½ inch in size

Temperature range (° F.)	Thickness of tape (inches)	Number of layers	Total thickness (effective)	Temperature range (° F.)	Thickness of tape (inches)	Number of layers	Total thickness (effective)
100-338.....	¾	1	¾	501-750.....	1 and ¾	2	1
339-388.....	1	1	1	751-900.....	1 and ¾	1 of each	1
389-500.....	1½	1	1½				

Table 5.—Thicknesses* of insulating materials for hot surfaces of machinery

Temperature range (°F.)	Asbestos felt, block or mineral wool blanket	Cement (N. D. Spec. 32C14, type B)	Temperature range (°F.)	Asbestos felt, block or mineral wool blanket	Cement (N. D. Spec. 32C14 type B)
100-338.....	1½	1½	501-750.....	3½	4
339-388.....	2½	2½	751-900.....	4½	5
389-500.....	3	3			

*Does not include finishing cement.

Table 6.—Thicknesses of insulating materials in inches for cold and refrigerated surfaces of machinery

Service	Temperature range (° F.)	Corkboard Fed. Spec. HH-C-561	Asbestos felt MIL-F-15091 types A or B	Mineral wool N. D. Spec. 32-I-5
Refrigerant.....	Below 0.....	6		
	0 to 35.....	4		
	36 and over.....	2		
Cold water.....	All.....		1½	1½

Thickness of asbestos felt insulation MIL-F-15091, types A and B, for cold water pipe and tubing, flanges, valves and fittings shall be 1 inch.

Thickness of mineral wool insulation, N. D. Spec. 32-I-5, for cold water pipe and tubing, flanges, valves and fittings shall be 1½ inches.

S39-2-f. Methods of application to pipe or tubing

Hot surfaces.

- Each layer of sectional or segmental pipe covering shall be applied with joints tightly butted together and shall be held in place by one of the following methods:

Not less than three separate loops per section of 18 gage (0.049 inch diameter) annealed black or hot dipped galvanized iron wire.

- Not less than three galvanized steel bands per section. Bands shall be wrapped with a layer of masking tape (UU-T-106, type II) when glass cloth or tape lagging is to be used.

- Where two layers of insulating material are used, apply the second layer over the first so that all joints are staggered.

- At flanged joints the molded pipe covering shall be stopped off in such a manner that the flange bolting may be removed easily. This may be done by stopping the pipe covering squarely and inserting a short removable section of molded pipe covering or the insulation may be beveled at an angle of 45 degrees.

For lagging see table 1 and paragraph S39-2-1.

- Cold surfaces.

- Untreated asbestos felt, water repellent asbestos felt, or low temperature mineral wool pipe covering shall be applied and held in place with 18 gage (0.049 inch diameter) hot dipped galvanized iron wire spirally wound on about 3-inch centers. Cover insulating material with one layer of water repellent and flameproof sheathing paper (MIL-P-15006). Paper shall be tightly wrapped and joints lapped 3 inches each way and sealed completely with adhesive cement (MIL-C-3316, type II).

- For lagging see table 1 and paragraph S39-2-1.

Refrigerated surfaces.

Apply sectional cork pipe covering with staggered end joints; longitudinal joints shall be at top and

bottom of pipe. At the time of installation coat the molded cork on all surfaces with the fire retardant vapor seal furnished for that purpose. Secure pipe-covering in place with 18 gage (0.049 inch diameter) copper covered steel wire spaced not greater than six loops to a 3-foot section. Wherever pipes pass through a nonwatertight insulated bulkhead into a refrigerated space, insulation shall extend 1 inch inside of refrigerated space. Pipe clamps of hangers shall fit over outside of cork covering and a galvanized sheet steel shield shall be installed between pipe clamp and insulation where piping rests in the hanger.

For lagging see table 1 and paragraph S39-2-1.

S39-2-g. Methods of application to valves, fittings and flanges

Hot surfaces.

Provide readily removable and replaceable covers on the following piping elements requiring insulation:

Flanged joints (except valve bonnet joints) on all sizes of main and auxiliary steam piping carrying steam having a total temperature of 389° F. (205 p. s. i. saturated steam) and over, including flanged joints on all root connections and root valves thereon, such as valve bypasses, drain connections, pressure gage connections, etc.

Flanged joints on piping and adjacent to machinery units which must be broken when these machinery units are opened for inspection and overhaul, such as steam exhaust connections, feed pump suction and discharge connections, steam drain connections, etc.

Valve bonnets on all valves over 2 inches in size, working pressure of 300 p. s. i. and over, carrying fluids 240° F. and over.

Pressure reducing and pressure regulating valves, pump pressure governors, and strainer bonnets.

Readily removable and replaceable covers for piping elements shall be made by one of the following methods:

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Covers shall be made in two halves filled with asbestos felt. They shall be sewed and quilted with wire inserted-asbestos yarn (Fed. Spec. SS-C-466, Type II) in such a manner as to provide a uniform thickness.

- 5 Asbestos cloth, wire inserted (Fed. Spec. SS-C-466, grade C) shall be used on inside of covers. Asbestos cloth (Fed. Spec. SS-C-466, grade B) shall be used on outside surface of cover if the temperature of the insulated surface does not exceed 500° F. For temperatures over 500° F., asbestos cloth (Fed. Spec. SS-C-466, grade D) shall be used on outside of cover. Flexible asbestos millboard, $\frac{3}{8}$ inch thick, shall be inserted between the asbestos felt and the asbestos cloth so as to retain cylindrical shape of cover. Hard asbestos millboard, $\frac{1}{4}$ inch thick, enclosed in asbestos cloth of the type used on the outside of the cover shall be sewn on ends of cover for strength and rigidity. Where the flange diameter is larger than outside diameter of adjacent pipe-covering, build-up pieces shall be made of asbestos felt encased in asbestos cloth (Fed. Spec. SS-C-466, grade D) and secured by stitching to inside of cover. The halves of the cover shall be secured around equipment by $\frac{1}{16}$ -inch diameter soft galvanized iron rope laced through brass or galvanized steel hooks or rings, or covers shall be secured by snap fasteners made of brass. Fastenings fixed to cloth lagging shall be backed up by washers on both sides of the cloth.

- Covers shall be made up of segments of block insulation of the same material used for pipe covering securely wired to frames of $\frac{1}{2}$ -inch square mesh of 18 gage (0.049 inch diameter) galvanized steel wire. Wire mesh frames inside and outside of block insulation shall have ends bent over and joints secured with 18 gage black annealed iron wire woven through the mesh. Insulating cement of same material as blocks shall be troweled smoothly over all surfaces of the mesh. Asbestos roll fire-felt (N. D. Spec. 32F1) may be used to build up cover where flange diameter is larger than the outside diameter of the adjacent pipe-covering. Covers shall be lagged with asbestos cloth (Fed. Spec. SS-C-466, grade D) tightly and smoothly fitted to envelop the outside and ends. Where double layer insulation is used the two sections of the cover shall be fitted together with a scarfed joint. Care shall be taken in the workmanship to insure straight and true jointing surfaces of the sections with the view of reducing the heat loss at the joints. Bands and eyelets of galvanized steel or lacing with rings, washers and wire shall be used for securing the cover around the equipment.

- 50 Covers shall be made of fibrous sectional pipe-covering (MIL-P-2781, classes c and f) of the same thickness as that on the adjacent piping. Where double layer insulation is used the two sections of the cover shall be fitted together with a scarfed joint. Covers shall be lagged with asbestos cloth (Fed. Spec. SS-C-466, grade D) tightly and smoothly fitted to envelop the outside and ends. Cloth may be cemented with an approved high temperature adhesive cement.

- Where the rigid type cover described above is not practicable, for example, because of restricted space, use flexible removable and replaceable covers of the type using asbestos felt, specified in paragraph S39-2-h. Spaces between inner lagging on removable covers for flanges or other irregular surfaces and such hot metal surfaces shall be filled with pieces of asbestos

felt so as to preserve the air cell structure but sufficiently tight to prevent any air circulation.

Permanent insulation for valves, fittings and flanges, shall be made by one of the following methods:

Layers of asbestos felt, MIL-F-15091, type A, shall be applied to a thickness $\frac{1}{2}$ -inch less than that of the adjacent pipe covering and secured with 18 gage (0.049 inch diameter) annealed black or hot dipped galvanized iron wire. A $\frac{1}{2}$ -inch thick layer of finishing cement shall be laid over the insulating material.

For sizes $3\frac{1}{2}$ inches and under, permanent insulation shall be of insulating cement, N. D. Spec. 32C14, type B, applied to a thickness $\frac{1}{2}$ -inch less than that of the adjacent pipe covering. After drying, a $\frac{1}{2}$ -inch layer of finishing cement shall be applied.

Insulation shall be of sectional or segmental pipe-covering or block of the same material and thickness as that on the adjacent piping. A $\frac{1}{2}$ -inch thick layer of finishing cement shall be laid over the insulating material.

Where practicable, asbestos cloth, Fed. Spec. SS-C-466, grade B, shall be used for lagging if the temperature of the insulated surface is over 500° F. Lagging may be of asbestos cloth or tape, Fed. Spec. SS-C-466, grade A or type IV respectively, or glass cloth or tape (N. D. Spec. 32G9) where the temperature of the insulated surface is 500° F., or less and for temperatures over 500° F. on applications such as butt-welding end fittings where it is desirable to lag the fittings with the material used on the tubing. Asbestos cloth and tape, Fed. Spec. SS-C-466, grade A and type IV respectively, and glass cloth or tape, N. D. Spec. 32G9 shall not be used where lagging will be in contact with hot metal surfaces.

Cold surfaces.

Removable covers shall not be used. Insulate as specified in paragraph S39-2-f for cold pipe.

Refrigerated surfaces.

Insulate as specified in paragraph S39-2-f for refrigerated pipe:

S39-2-h. Methods of application to machinery and equipment

Hot surfaces.

Machinery and equipment such as boilers, turbines, boiler feed pumps and feed booster pumps, deaerating feed tanks, etc., shall be covered with asbestos felt, MIL-F-15091, type A, block insulating material, N. D. Spec. 32-I-3, mineral wool blanket, N. D. Spec. 32-I-2, or insulating cement N. D. Spec. 32C14, type B. Thicknesses shall be as shown in table 5.

Block, felt and blanket insulating materials shall be securely held in place with hot-dipped galvanized iron wire; 1-inch mesh of 18-gage (0.049 inch diameter) galvanized iron wire shall then be spread over the surface and secured by wiring. Before lagging insulating material, use insulating cement to fill all crevices, smooth all surfaces, and completely coat the wire netting.

Apply insulating cement, N. D. Spec. 32C14, type B, in successive layers of one-half to 1-inch thickness. Allow each layer to dry before applying the next coat and use 1-inch mesh of 18-gage galvanized iron wire between layers.

Lay a coating of finishing cement, 1/2-inch thick, over the insulating material.

Lagging shall be in accordance with Table 1 and paragraph S39-2-1.

- 5 Large flanges such as on turbines shall be insulated with readily removable and replaceable covers made by one of the following methods:

- Covers shall be filled with asbestos felt and shall be sewed and quilted with wire inserted asbestos yarn, 10 Fed. Spec. SS-C-466, type II, so as to provide a uniform thickness. Use asbestos cloth, wire inserted, Fed. Spec. SS-C-466, grade C, on inside of covers. Use asbestos cloth, Fed. Spec. SS-C-466, grade B, on outside surface of cover if temperature of insulated surface does 15 not exceed 500° F. For temperatures over 500° F., use asbestos cloth, Fed. Spec. SS-C-466, grade D, on outside of cover.

- 20 Make covers in sections formed of insulating block (N. D. Spec. 32-I-3) held together with approved high temperature adhesive cement and covered with 1/2-inch of finishing cement over which asbestos cloth shall be applied.

- Fibrous adhesive cement (MIL-C-15199) may be used with chemically compatible insulating material for 25 fabricating covers.

- Removable and replaceable insulation shall fit accurately and shall project over adjacent permanent insulation. Secure removable covers to equipment by 30 3/16-inch diameter soft galvanized iron rope laced through brass or galvanized steel hooks or rings, or secure covers by brass snap fasteners.

- Spaces between inner lagging on removable covers for flanges or other irregular surfaces and such hot 35 metal surfaces shall be filled with pieces of asbestos felt so as to preserve the cell structure but sufficiently tight to prevent any air circulation.

- Insulation of manhole covers, handhole covers, drain plugs, and other openings in general as may be required for accessibility shall be readily removable and re- 40 placeable without injury.

- Insulate uptakes with fibrous glass sheets, MIL-I-15475, or with mineral wool felt, N. D. Spec. 32-I-2. Thickness shall be such as to fill the space described in General Specification, section S52-1.

- 45 Clips or hooks or other fastenings for securing insulation are not to be brazed or welded to nonferrous parts of distilling plant equipment.

All main, auxiliary and distilling condensers shall be insulated where the normal operating temperature

is 125° F. or more. Where the normal operating temperature is less than 125° F. such equipment shall not be insulated, unless otherwise specified or approved.

Flanges and joints of apparatus operating below atmospheric pressure shall, in general, not be insulated so that inspection for leaks can readily be made.

Cold surfaces.

Insulate as specified in paragraph S39-2-f for cold pipe to a thickness in accordance with table 6.

Refrigerated surfaces.

Insulate as specified in paragraph S39-2-f for refrigerated pipe to a thickness in accordance with table 6.

S39-2-i. Lagging

Provide insulating material with protective lagging conforming to table 1. Fibrous glass lagging shall not be used where subject to abrasion or mechanical injury. Fit lagging smoothly, tape being lapped as required to restrain insulation. Secure asbestos lagging to insulating material and to itself with fibrous insulating adhesive cement (MIL-C-15199) or adhesive cement (MIL-C-3316, type II). Fibrous adhesive cement (MIL-C-15199) shall not be used for securing to metal, nor used with fibrous glass lagging. Secure 70 fibrous glass lagging to insulating materials, itself, and to metal surfaces with adhesive cement (MIL-C-3316, type II). Sodium-silicate shall not be used for securing lagging. Cloth lagging shall be sewed only when adjacent to hot surfaces (such as flanges) where lagging may be exposed to high temperatures.

Use metallic lagging wherever necessary for protection of insulating material from damage. It shall be secured with hardened self-tapping screws using lap joints with a bead on the exposed edge. Cloth or tape lagging is not necessary where metallic lagging is used.

85 Metallic lagging for piping and applications where the insulation acts as a firm support shall be hot dipped galvanized sheet steel, N. D. Spec. 47S29, 0.014 inch nominal thickness. Lagging of not less than 0.025 inch nominal thickness shall be used for other applications.

90 Fuel oil service piping from fuel oil heaters to and including burner headers shall be lagged with sheet metal.

Paint asbestos and glass cloth or tape lagging with one coat of fire retardant white paint, JAN-T-702, 95 after installation.